CODEX ALIMENTARIUS COMMISSION E

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 10 **CX/FH 25/55/10**

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD HYGIENE

Fifty-fifth Session

Nashville, Tennessee, United States of America

15–19 December 2025

NEW WORK / FORWARD WORKPLAN

(PR OPOSALS IN REPLY TO CL 2024/64-FH)

(Prepared by the United States of America)

Background

1. The 54th Session of the Codex Committee on Food Hygiene (CCFH54) agreed to the Forward Workplan and requested the Codex Secretariat to issue a circular letter requesting proposals for new work in advance of CCFH55. CCFH54 also agreed to re-establish the Working Group for Establishment of CCFH Work Priorities to be chaired by the United States of America to meet in conjunction with CCFH55 to consider any proposals for new work and to update the committee's forward work plan (REP24/FH, para 196).

2. CL 2024/64-FH was sent out to all Members and Observers in July 2024. Members were invited to propose new work for consideration by the above working group by 1 September 2025, in accordance with the *Criteria for the Establishment of Work Priorities* and with the "Process by which the Codex Committee on Food Hygiene (CCFH) will undertake its work."

Proposals to prepare new standards and codes of hygienic practice or to revise existing standards

3. Two work proposals were submitted in response to CL 2024/64. These included:

   - A proposal for new work submitted by Singapore and China on the development of a Code of hygienic practice for manufacturing of cell-based foods (see Appendix II).
   - A second proposal for new work submitted by Chile on the revision of *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CXC 8-1976) (see Appendix III). Although developed by the TFPHQFF, which no longer exists, the microbiological food safety aspect of this proposal is of relevance of CCFH.

CCFH Forward Workplan

4. Using the Forward Workplan agreed by CCFH54 (REP24/FH, para 196 and Appendix XI) as a starting point, an updated Forward Workplan for consideration by CCFH55 is attached as Appendix I. Changes include deletion of the rows for *Guidelines for the Control of* Campylobacter *and* Salmonella *in Chicken Meat* (CXG 78-2011), *Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food* (CXG 79-2012), and *Guidelines on the Application of General Principles of Food Hygiene to the Control of* Listeria monocytogenes *in Foods* (CXG 61-2007) from Part 1 of the Appendix Table since work on these topics was approved by CAC47 and work is now ongoing.

5. "The Process by Which the Codex Committee on Food Hygiene (CCFH) Will Undertake Its Work" indicates that standards older than five years or those with duplication or inconsistency with existing codes should also be assessed to determine their need for revision. These are all listed in Appendix I Part 2.

Recommendations

6. If CCFH55 is successful in completing work on the *Guidelines for the Safe Use and Reuse of Water in Food Production and Processing* - Annex II on Fish and Fishery Products and Annex IV on Water Fit-for-Purpose

Assessment, Safety Management, and Technologies for Recovery and Treatment of Water for Reuse, the *Guidelines for the Control of* Campylobacter *and* Salmonella *in Chicken Meat* (CXG 78-2011), or the *Guidelines on the Application of General Principles of Food Hygiene to the Control of* Listeria monocytogenes *in Foods* (CXG 61-2007), then it is possible that the Committee may take on one or both of the new work proposals for consideration at CCFH56.

7. With respect to the new work proposals to revise existing guidelines, Members should consider the ranking criteria that should be applied.

8. An additional consideration for CCFH55 will be ongoing work regarding alignment of texts with the revised *General Principles of Food Hygiene* (GPFH) (CXC 1-1969). CCFH54 agreed to establish an EWG on the alignment of existing CCFH standards with the GPHF, chaired by China and co-chaired by the United Kingdom and the European Union.

9. CCFH55 should review its forward workplan (Appendix 1) in accordance with the "Process by which the Codex Committee on Food Hygiene (CCFH) will undertake its work"[1] and come prepared to rank the projects for which there is a "Yes" in the column indicating there is information for an update. (Note that in some cases the information is not yet available, pending work by other entities.)

[1] "Process by which the Codex Committee on Food Hygiene (CCFH) will undertake its work

Appendix I

CCFH FORWARD WORKPLAN

Part 1									
Title of Work	**Last Revision**	**Information to Update (Yes/No)[2]**	**Impact to Public Health (High= 20/ Medium = 14/ Low = 8)**	**Trade Impact (10/5/4/2/0)[3]**	**Project document/ discussion paper (Yes/No)**	**FAO/WHO assistance needed? (Yes/No)**	**Alignment required with the revised CXC 1-1969**	**Comments**	**Total**
Code of Practice for Processing and Handling of Quick Frozen Foods (CXC 8-1976)	2008	Yes			Yes			This CoP was originally developed by the TFPHQFF; however, the proposed changes need to be considered from a microbiological food safety perspective.	
Development of Code of Hygienic Practice for Manufacturing of Cell-Based Foods	NA	Yes			Yes				

[2] Information to Update (Currency of information): Is there new information/data that would justify the need to review the existing code(s) or establish a new one? Are there new technologies that would justify the need to review existing codes or establish a new one? Is there duplication or inconsistency with existing codes that should be addressed? If there is an existing code in place and a determination is made that the code is sufficient, no new work should proceed.

[3] Global Trade Impact, High Consumption: 10; Regional Trade Impact, High Consumption: 5; Global Trade Impact, Low Consumption: 4; Regional Trade Impact, Low Consumption: 2; No trade impact: 0

Code of Practice on Food Allergen Management for Food Business Operators (CXC 80- 2020)	2019	Yes (FAO/WHO Expert consultations) /No (CCFL input)			Yes		Yes	CCFL48 completed revisions to provisions relevant to allergen labelling in the *General standard for the labelling of pre-packaged foods* (CXS 1-1985), in particular the definitions and the new list of foods or ingredients that should be declared on a label. There is now a need to ensure consistency of the *Code of practice on allergen management for food business operators* (CXC 80–2020) with the updated CXS 1-1985. Work on Precautionary allergen labelling continues, although it has been adopted at Step 5 and FAO/WHO have in November 2025 convened another expert meeting on this topic. Consideration needs to be given to how to initiate the alignment updates or plan for a more comprehensive update, perhaps at the next session.	30
Code of Hygienic Practice for the Storage of Cereals	N/A	Yes			Yes[4]		N/A		13
Part 2									
Texts below are ordered most recent to oldest. There is no new information for an update, however, revisions may be needed for alignment with CXC 1 and other documents.									
Title of Work	**Last Revision**	**Information to Update (Yes/No)[5]**	**Impact to Public Health (High= 20/ Medium = 14/**	**Trade Impact (10/5/4/2/0)[6]**	**Project document/ discussion paper (Yes/No)**	**FAO/WHO assistance needed? (Yes/No)**	**Alignment required with the**	**Comments**	**Total**

[4] Discussion paper on development of Code of Hygienic Practice for the storage of cereals (prepared by India) FH/44 CRD 9, included in the Forward Workplan by the 44th session of the CCFH, 12-16 November 2012

[5] Information to Update (Currency of information): Is there new information/data that would justify the need to review the existing code(s) or establish a new one? Are there new

			Low = 8)				**revised CXC 1-1969**		
Code of Hygienic Practice for Low-Moisture Foods (CXC 75- 2015)	2018	No					Yes	Sections should be re- aligned with revised GPFH sections.	
Code of Hygienic Practice for Fresh Fruits and Vegetables (CXC 53-2003)	2017	No					Yes	GPFH definitions - types of water should reference updated text of GPFH/ expert information	
Guidelines on the Application of General Principles of Food Hygiene to the Control of Foodborne Parasites (CXG 88- 2016)	2016	No					Yes	Section 3.1 - should update reference to align with revised GPFH to 'section 2.1'. FAO have also convened two expert meetings in 2025 on foodborne parasites (see agenda item 3) Updated structural alignment proposed in CX/FH 25/55/6.	
Guidelines for the control of non-typhoidal Salmonella in Beef and Pork (CXG 87-2016)	2016	No					Yes	Editorial: 8h) Should move superscript 17 to end of second sentence and reference direct to Section 7.3 of revised GPFH. Similar for superscript 22 – repeat as above.	
Guidelines for the Control of Trichinella spp. in Meat of Suidae (CXG 86-2015)	2015	No					Yes	FAO have convened two expert meetings in 2025 on risk assessment of helminth parasites in foods (see agenda item 3) Updated structural alignment proposed in CX/FH 25/55/6.	

technologies that would justify the need to review existing codes or establish a new one? Is there duplication or inconsistency with existing codes that should be addressed? If there is an existing code in place and a determination is made that the code is sufficient, no new work should proceed.

[6] Global Trade Impact, High Consumption: 10; Regional Trade Impact, High Consumption: 5; Global Trade Impact, Low Consumption: 4; Regional Trade Impact, Low Consumption: 2; No trade impact: 0

Guidelines for the Control of Taenia saginata in Meat of Domestic Cattle (CXG 85-2014)	2014	No					Yes	FAO have convened two expert meetings in 2025 on risk assessment of helminth parasites in foods (see agenda item 3) Updated structural alignment proposed in CX/FH 25/55/6.	
Principles and Guidelines for the Conduct of Microbiological Risk Assessment (CXG 30- 1999)	2014	No					No	Hazard definition should be updated. Hazard identification should reference GPFH as a starting point.	
Principles and Guidelines for the Establishment and Application of Microbiological Criteria related to Foods (CXG 21-1997)	2013	No					No	Editorial updates: 4.1 (para 11) should be updated with reference to GPFH. Suggest "The choice of the approach should be aligned with GPFH (CXC 1-1969), the risk management objectives and decisions relating to food safety and suitability." 4.12 should be updated to refer to Section 7.4 of revised GPFH document.	
Code of Hygienic Practice for Collecting, Processing and Marketing of Natural Mineral Waters (CXC 33-1985)	2011	No					Yes	GPFH reference should be dated (CAC/RCP 1-1969). HACCP should be referenced to revised GPFH. Sections references to GPFH should be updated to align with revised GPFH sections.	
Code of Hygienic Practice for Powdered Formulae for Infants and Young Children (CXC 66- 2008)	2009	No					Yes	Section formatting should be updated to align with revised GPFH sections. Review of HACCP should occur to align with revised GPFH GHP and HACCP use. Remove reference to HACCP annex.	
Code of Hygienic Practice for Milk and Milk Products (CXC 57-2004)	2009	No					Yes	Format follows GPFH sections therefore will need re-alignment with revised GPFH. HACCP reference should be changed from 'Annex' to 'Chapter Two'. Use of HACCP should be re-	

								evaluated in line with revised GPFH approach. Consider use of GHP and HACCP as appropriate to cover hygienic practice, rather than HACCP alone. Allergens need re-evaluating in relation to milk itself as an allergen, rather than allergens from other sources. Water should be re-evaluated to align with revised GPFH and water advice.	
Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM) (CXG 63-2007)	2008	No					No	Annex II. The Introduction should reference GPFH as the foundation for integration of MRM metrics within a food safety control system. Other wording within this annex should be re-considered for revision given the revised GHP/HACCP approach within the revised GPFH Editorial: Definitions - should reference GPFH and cover both GHP and HACCP. This would also include relevant definitions (hazard, control measure, CCP, CL etc.). 6.1.2 – should reference GPFH as source guidance for specific documents and guidelines.	
Code of Hygienic Practice for Eggs and Egg Products (CXC 15-1976)	2007	No					Yes	Context of use of hazard analysis, HACCP / HACCP system should be reviewed and updated in line with revised GPFH. Contents and referenced sections of GPFH should be updated throughout the document aligning as appropriate to revised sections	

								of GPFH. Allergen information should be specifically referenced.	
Code of Hygienic Practice for Meat (CXC 58-2005)[7]	2005	No					Yes	Should be updated for sections referenced to GPFH to align with revised GPFH sections.	
General Standard for Irradiated Food (CXS 106-1983)	2003	No						remove reference to Rev 3 and wording on HACCP as HACCP covered within GPFH text	
Code of Practice for Radiation Processing of Food (CXC 19- 1979)	2003	No					Yes	Introduction – last paragraph should be updated to reflect HACCP application as in revised GPFH. Sections should be updated to align with revised GPFH.	
Code of Hygienic Practice for Bottled/Packaged Drinking Waters (other than natural mineral waters) (CXC 48-2001)	2001	No					Yes	GPFH reference should be updated to be consistent with requirements (remove Rev 3). Sections should be re- aligned to referenced sections within revised GPFH. Definitions reference should be updated to revised GPFH Definitions (not section 2.3). HACCP reference should be to the revised GPFH, not an Annex. Should consider water usage and reference to updated water section within GPFH and expert reports.	

[7] Code developed by the Codex Committee on Meat Hygiene

Code of Hygienic Practice for the Transport of Food in Bulk and Semi-packed Food (CXC 47-2001)	2001	No					Yes	GPFH references should be consistent with current requirements, e.g. CAC/RCP 1-1969. Sections should be aligned with the revised GPFH sections. HACCP and hazard identification as mentioned in section 5 should be checked to see whether the wording here adds any further specific application above the HACCP approach in Chapter 2 of the revised GPFH. 5.5 Water should reference updated information in line with revised GPFH. Appendix on Hurdles – should be revised with consideration of HACCP text within Chapter 2 revised GPFH	
Code of Hygienic Practice for Refrigerated Packaged Foods with Extended Shelf-life (CXC 46-1999)	1999	No					Yes	Sections will need re- alignment with the revised GPFH. Section 5.1 should be revised in accordance with chapter 2 HACCP in the revised GPFH	
Code of Hygienic Practice for Precooked and Cooked Foods in Mass Catering (CXC 39- 1993)	1993	No						GPFH references should be updated (first reference to GPFH has no dated number; second reference in 5.2.1 is obsolete referring to 1985 GPFH). Explanatory preface C should be revised and aligned with HACCP application within the revised GPFH. Remove out- of- date references. Use of hazard and CCP notes throughout the document should be revised and aligned as necessary with GHP/HACCP application in the revised GPFH. Sections should	

								be updated to align with revised GPFH sections and be complementary to the GPFH. Definitions (contamination, disinfection, food handler, food hygiene) should be updated to align with the revised GPFH definitions and other definitions should be included, e.g. to replace 'potentially hazardous food'. HACCP definitions should be referenced to GPFH if not included. Section 4.3.12 Water Supply should be updated and aligned with revised GPFH. Allergen management should get specific mention for mass catering and be referenced to the revised GPFH. Noting that this text has some text on clostridia, FAO have convened an expert meeting on microbiological risk assessment of toxigenic clostridia in foodborne disease in 2025	
Code of Hygienic Practice for Low-acid and Acidified Low-acid Canned Foods (CXC 23-1979)	1993	No					Yes	Definitions - cleaning, disinfection, and potable water should be updated to align with revised GPFH. Sections should be updated to align as appropriate with revised GPFH. GHP and HACCP application should be considered and updated to align with use in revised GPFH, including Appendix IV (should have wider application than salvaged cans).	
Code of Hygienic Practice for Aseptically Processed and Packaged Low-acid Foods (CXC 40-1993)	1993	No					Yes	GPFH references should be updated to align with revised GPFH. Section and sub section references should be updated to align with revised GPFH.	

								Sections and contents should be updated to align with and be complementary to revised GPFH. HACCP and its application should be referenced to revised GPFH. Definitions (cleaning, disinfection), should be updated to align with revised GPFH. Water should be aligned with revised GPFH.	
Guideline Procedures for the Visual Inspection of Lots of Canned Foods for Unacceptable Defects (CXG 17-1993)[8]	1993	No					Yes		
Code of Hygienic Practice for Canned Fruit and Vegetable Products (CXC 2-1969)	1969	No					Yes	Needs revision and should reference GPFH as supporting text in a Scope and Use section. Sections should be aligned with the revised GPFH, including definitions. References to water use and supply should refer also to updated information provided by FAO/WHO on water. Note use of hazard (hygienic and health) and this should be revised in line with current definition of hazard.	
Code of Hygienic Practice for the Processing of Frog Legs (CXC 30-1983)	1983	No					Yes	GPFH should be referenced earlier as supporting text for whole document. Definitions should be updated (contamination, disinfection) to align with revised GPFH. Sections should be updated to	

[8] Documents developed by the Codex Committee on Processed Fruits and Vegetables.

								align with revised GPFH, including 5.2.1 which currently has reference to GPFH. GHP and HACCP should be applied across the whole document as appropriate and in accordance with the revised GPFH.	

Appendix II

DISCUSSION PAPER FOR NEW WORK ON THE DEVELOPMENT OF CODE OF HYGIENIC PRACTICE FOR MANUFACTURING OF CELL-BASED FOODS

(Prepared by Singapore, China, Republic of Korea, Saudi Arabia and the United Kingdom)

Background

1 "Cell-based food[9] production" is a working term that has been used by the FAO and WHO to describe the growing of animal agricultural products directly from cell cultures instead of using livestock. Cell-based food utilises novel technologies that have not been used in food previously and has been explored as a potentially sustainable option to complement the conventional livestock agricultural system. Such production technologies/ system may help to support increasing global demand for protein for human consumption and tackle global food insecurity.

2 In 2022, the FAO and WHO conducted a comprehensive food safety hazard identification of cell-based food production[10]. While some hazards are already well-known and exist in conventionally produced foods, there are additional hazards unique to the production of cell-based foods due to the nature of the materials, inputs, ingredients, equipment and processes that may not have been used previously for food production. For instance, the cell culture media used to grow cells are nutrient dense, providing ideal growth conditions for microbes. This is further exacerbated by the numerous steps involved in the expansion of cells, which increases the risk for microbial contamination.

Discussions related to cell-based food at Codex

3 Cell-based foods were first discussed at Codex as part of discussions on New Food Sources and Production Systems (NFPS) at CAC44 (2021) in response to a FAO-WHO document seeking advice on addressing NFPS related issues. Subsequently, a Circular Letter (CL) was issued on the topic and further discussion held at CAC45 (2022). As there were diverse views on whether existing Codex mechanisms were sufficient to address new work proposals on NFPS, a second CL was issued to identify specific topics for more discussion, including identification of topics that the current Codex mechanisms could not address.

4 NFPS was further discussed extensively at CAC46 (2023), where there was a general recognition on the importance and relevance of NFPS among Members and Observers. CAC46 highlighted the importance of addressing challenges posed by NFPS and the important role Codex could play in this and noted that current Codex working mechanisms were adequate to address new work proposals on NFPS. Additionally, CAC46 encouraged Members to submit discussion papers or new work proposals either to active Codex Committees or to the Executive Committee through the Codex Secretariat.

5 Leading up to the discussions at CCEXEC86, Singapore engaged with Members across all Codex Regions, in meetings coordinated by the Regional Coordinators. During these meetings, there was general recognition from Members of the benefits and the need for Codex guidance to ensure food safety of cell-based foods. Members also generally expressed interest to have a better understanding of the importance of the new work and how Codex could proceed to carrying out discussions on cell-based foods.

6 During CCEXEC86, the Member from Asia, through its advisor, highlighted the intention of Singapore to submit two new work proposals on cell-based foods (EXEC/86 CRD02). CCEXEC86 recommended that the proposed guidelines on safety assessment may be submitted to CCFA, and the proposed code of hygienic practice be submitted to CCFH in response to the request for new work proposals.

7 CAC47(2024) noted the intention by Singapore and China to submit new work proposals on cell-based foods and member countries generally expressed interest in this initiative. Singapore and Saudi Arabia also co-

[9] In this document, the term "cell-based foods" is used as a working terminology to indicate food produced through the culturing of cells isolated from animals. This includes cells isolated from poultry, bovine, porcine, fish and crustacean sources.

[10] FAO & WHO. 2023. Food safety aspects of cell-based food. Rome. https://doi.org/10.4060/cc4855en

organised a side event during CAC47 to increase awareness of cell-based foods and how Codex can help to address food safety challenges of cell-based food.

8 More recently, Singapore and China introduced a discussion paper for new work on the developments of guidelines for food safety assessment of cell culture media components for cell-based food production (FA55/CRD06). CCFA55 noted support on the need to consider the establishments of Codex guidance on cell-based foods to ensure consumer safety and facilitate fair trade practices and agreed to form an electronic working group to further develop the project document.

Importance of establishing internationally harmonized guidelines for manufacturing of cell-based food

9 The landscape of cell-based food manufacturing is rapidly evolving, with facilities already established or under development across multiple jurisdictions, such as China, Israel, Malaysia, Netherlands, Singapore, Spain and Thailand. The announcement of a major research centre in Korea, set to commence operations in 2027, further demonstrates the growing global interest in this sector. This widespread development across different regions underscores the urgent need for harmonized guidelines to ensure consistent safety standards and facilitate international trade.

10 While initial efforts by organisations like the Good Food Institute (GFI) and the International Organization for Standardisation (ISO) have begun to address these challenges, the absence of comprehensive international standards through Codex Alimentarius creates uncertainty for both industry players and regulatory authorities. This regulatory gap could lead to inconsistent safety standards, trade barriers, and varying levels of consumer protection across different jurisdictions. Furthermore, the unique technical challenges of cell-based food production, including aseptic processing requirements and novel biological considerations, underscore the critical importance of establishing harmonized guidelines that can ensure consistent safety standards and facilitate the responsible development of this innovative food sector.

Ensuring safety of the manufacturing process of cell-based foods

11 The production of cell-based food presents distinct food safety challenges that require careful consideration within existing food safety frameworks. Primary concerns include biological contamination risks, particularly the potential transmission of zoonotic diseases and pathogens (notably *Mycoplasma* species), residual chemicals from production processes (such as culture media components), and the maintenance of genetic stability in continuously cultivated cell lines. Downstream processing and formulation introduce further complexities, including the potential allergenicity of novel ingredients and scaffolding materials, product stability during storage, and the management of process-induced chemical changes.

12 While established food safety principles remain relevant, the new work proposal seeks to build upon the General Principles of Food Hygiene (CXC 1-1969) to address these emerging challenges in cell-based food manufacturing. This would help prevent unhygienic practices and conditions in the production, processing, and handling of cell-based food products while providing regulators and industry members with clear, comprehensive guidance tailored to the specific requirements of cell-based food production facilities for effective hazard control and safety assurance.

13 In addition, harmonised standards would support consistent implementation of food safety controls across jurisdictions, facilitate international trade, and build confidence in the safety of cell-based foods among consumers and trading partners, ultimately leading to enhanced public health protection.

Assessment Against CCFH Criteria

14 This proposal has been evaluated against the criteria outlined in the CCFH Information Document for undertaking work. Our assessment demonstrates that this work meets the currency of information criterion, as evidenced by the novel technology requiring specific hygiene controls, recent regulatory approvals (2023 - 2024), and pilot facilities established with scaling up of production in progress. The public health impact is assessed as high (20 points), considering the unique biological hazards in cell culture processes, complex aseptic processing requirements, multiple critical control points requiring specific controls, and novel ingredients and processes requiring safety validation. The trade impact is evaluated as global with high consumption potential (10 points), supported by multiple jurisdictions developing regulatory frameworks,

international facilities being established, growing global market potential, and significant cross-border implications for supply chains.

Recommendations

15 CCFH55 is invited to consider the project document on the development of a Code of Hygienic Practice for Manufacturing of Cell-Based Foods (Annex 1). For reference, a preliminary structure of the proposed Code is also provided in Annex 2. This document is shared for information purposes only at this stage and could serve as a starting point should this new work be approved.

Annex 1

PROJECT DOCUMENT

DEVELOPMENT OF CODE OF HYGIENIC PRACTICE FOR MANUFACTURING OF CELL-BASED FOODS

Purpose and scope of the Standard

1 The purpose of the proposed new work is to develop a comprehensive code of hygienic practice for the manufacturing of cell-based foods. The scope encompasses cell-based foods covering the entire production chain from cell bank to final product processing. The code will address specific hygiene requirements essential for cell-based food production facilities, from cell banking to final product. This would include, although not limited to, environmental and contamination controls for cell culture operations, management of biological materials, and specialized waste handling procedures. The code will also address facility design requirements, operating procedures, storage conditions, temperature controls, personnel hygiene requirements, and measures to prevent cross-contamination. This comprehensive approach aims to ensure the safe production of cell-based foods through appropriate hygienic controls throughout the manufacturing process.

Relevance and Timeliness

2 At CAC44, the FAO and WHO called for Codex to recognize food system innovations that address challenges related to feeding a growing global population while promoting sustainable food production. This was further reinforced at CAC46, where discussions extensively highlighted the importance of addressing challenges related to new food sources and production systems (NFPS) and encouraged the submission of new work proposals in this area. These developments reflect the growing recognition of the need for Codex to establish international frameworks and guidelines to ensure the safety and regulation of NFPS on a global scale.

3 Cell-based foods are being studied as a potential contributor to addressing global food challenges. These challenges include considerations around land use, climate impacts, and food security. The production method presents possibilities for complementing existing food systems through different approaches to resource utilisation. Various studies are examining the comparative resources requirements, including water, land, and energy inputs, between cell-based and conventional production systems. As research and development in this field continues, the role of cell-based foods in contributing to food system diversity and resilience remains an area of active investigation and discussion among stakeholders in the food sector.

4 An increasing number of countries have granted approval or allowed the commercial sale of cell-based foods. As of the 2nd quarter of 2025, Singapore, the United States of America, and Israel have approved these products for commercial sale. More recently, Food Standards Australia New Zealand (FSANZ) has assessed a cell-based food product to be safe. Other Codex members including Switzerland, the Republic of Korea, and the European Union are also actively reviewing safety assessments or modifying their safety assessment criteria. Additionally, cell-based food companies that are approved have already started producing at commercial scale in manufacturing facilities or are exploring the establishment of production facilities in other Codex members such as China, Israel, Malaysia, Netherlands, Singapore, Spain, Thailand, Republic of Korea.

5 However, the establishment of commercial production facilities is hindered by the absence of international guidance on acceptable good manufacturing practices[11]. While the Codex General Principles of Food Hygiene (CXC 1-1969) provides valuable foundational guidance, it does not adequately address the specific hygiene requirements for cell-based food production. Implementing Good Manufacturing Practices and incorporating Good Cell Culture Practice during production is essential to ensure the safety and quality of cell-based food products. Areas such as air cleanliness levels, segregation of rooms for different purposes (e.g., cell culture room, media preparation room), and the management of general and biological waste are crucial considerations that are unique to this production system.

6 It is therefore timely for Codex members to consider the development of a code of hygienic practice for manufacturing of cell-based foods to help ensure that risk managers and cell-based good businesses apply consistent safety measures when looking at hygienic production of such foods, and prevent potential divergence in regulatory approaches across jurisdictions.

Main aspect to be covered

[11] Good Food Institute. (2023). Trends in cultivated meat scale-up and bioprocessing. Good Food Institute Technical Report.

7 The proposed code will build upon the General Principles of Food Hygiene (CXC 1-1969) to provide regulators and industry members with clear and comprehensive guidance tailored to the specific requirements of a cell-based food production facility. This would help prevent unhygienic practices and conditions in the production, processing, and handling of cell-based food products, ultimately leading to enhanced public health protection. The code will address critical aspects including facility design requirements, environmental monitoring for different cleanliness zones, aseptic processing controls, and biological material handling and storage. Specific attention will be given to personnel hygiene requirements, training needs, cross-contamination prevention, waste management procedures, and quality control measures for cell culture media and ingredients. Additionally, the code will establish requirements for documentation, traceability, and process validation (Appendix 2).

An assessment against the Criteria for the Establishment of Work Priorities

Consumer protection from the point of view of health, food safety, ensuring fair practices in the food trade and taking into account the identified needs of developing countries

8 From a consumer protection perspective, the code will address food safety hazards unique to cell-based food production through comprehensive hygiene controls. By providing clear guidance on hygiene controls specific to cell-based food production, the code will contribute significantly to protecting consumer health and ensuring food safety. This standardized approach will help establish consistent safety measures across different production facilities and jurisdictions, thereby enhancing consumer confidence in cell-based foods.

Diversification of national legislation and apparent resultant or potential impediments to international trade.

9 The absence of internationally harmonised guidance on good manufacturing practices specific to cell-based food production facilities may lead to divergent regulatory approaches across jurisdictions. While the cell-based food industry is still emerging, regulatory frameworks are already being developed independently by different countries. For instance, Singapore has set out requirements for licensing of cell-based food production and FSANZ has recently approved cell-based food products and drafted specific food safety requirements for cell-cultured food processing. As more countries develop their own requirements, there is potential for regulatory divergence that could create technical barriers to trade as the sector matures and commercialisation expands globally.

10 The proposed work aims to address this gap by providing clear and comprehensive guidance on the specific requirements of such facilities. This guidance will serve as a valuable point of reference for countries seeking to establish or enhance their regulations in this domain.

Work already undertaken by other international organizations in this field and/or suggested by the relevant international intergovernmental body(ies)

11 While some organizations have begun addressing aspects of cell-based food production, current guidance remains limited and fragmented. The Good Food Institute (GFI) Brazil published a comprehensive HACCP plan development guide for cell-based meat in 2023, which provides valuable initial guidance for the production of cell-based food products. This work identifies several key hazards specific to cell-based food production, including biological hazards from cell culture processes, chemical hazards from growth factors and cell culture media components, potential novel substances from cell modification, and physical hazards unique to bioreactor-based production. The document also outlines specific control measures needed for clean room operations and aseptic processing.

12 At the international standardization level, ISO Technical Committee 34 (TC 34) has initiated work on ISO/NP 25351 "Principles for production of cell cultured food products," with support from 24 member countries. A dedicated Working Group (WG 30) "Tissue cultured and cellular food technology products" has been established to develop this standard, which will address principles for cell sourcing, culture methods, bioreactor systems, and quality control measures. This work builds upon existing ISO standards relevant to cell-based production, including requirements for biobanking, cell line characterization, and cell line authentication. Additionally, FAO/WHO has conducted preliminary work on food safety aspects of cell-based foods through expert consultations and scientific reviews.

13 However, while these initiatives from GFI Brazil, ISO, and FAO/WHO represent important steps forward, they highlight significant gaps that require international standardization through Codex. The ISO work, while valuable for technical specifications, does not address the comprehensive food safety and hygiene requirements needed for international trade. Similarly, while FAO/WHO's preliminary work provides important scientific insights, comprehensive international hygiene standards to address food safety challenges specific to this production method are still lacking. These gaps include the need for harmonized hygiene requirements for cell-based food production facilities, internationally agreed-upon standards for biological material handling in food production, standardized approaches for preventing cross-contamination in hybrid

facilities producing both conventional and cell-based foods, and specific guidance on waste management for biological materials.

Amenability of the subject of the proposal to standardization.

14 The subject of the proposal is amenable to standardization as the guideline would be developed using science-based risk assessment approach. The production process comprises clearly definable steps with identifiable critical control points, including standardised protocols for cell banking and maintenance, defined parameters for environmental monitoring, and measurable criteria for process controls. The ability to establish verifiable requirements for personnel qualifications, quantifiable specifications for facility design and operation, and clear requirements for documentation and record-keeping further demonstrates the amenability of this subject to standardisation. These elements can be systematically addressed through science-based standards that ensure consistent implementation across different jurisdictions.

Relevance to Codex Strategic Objectives

15 The proposed work aligns significantly with several Codex strategic goals from the Codex Strategic Plan 2026-2031:

- Strategic Goal 1: Response to Members' needs for protecting the health of consumers and ensuring fair practices in the food trade in an evolving global landscape by developing science-based standards and related texts

  The development of a Code of Hygienic Practice for cell-based foods addresses Members' needs for science-based guidance for this type of NFPS. This work would support national authorities in establishing appropriate safety controls and regulatory frameworks, while facilitating fair trade practices through harmonised standards. The Code would incorporate current scientific understanding of cell-based food production processes and associated food safety considerations, ensuring consumer protection in this evolving food landscape.

  This work necessitates collaboration with key international organizations including FAO, WHO, international scientific bodies, and relevant technical institutions. The development process will foster partnerships with organizations working in cellular agriculture, food safety, and NFPS, promoting a coordinated approach to addressing food security and safety challenges.

- Strategic Goal 4: Maximize the impact of Codex by increasing the visibility and use of standards

  The Code will serve as a crucial reference point for countries developing or enhancing their regulatory frameworks for cell-based foods. By providing comprehensive guidance in this emerging sector, the Code will support broader adoption and implementation of Codex standards. This work will increase Codex's visibility in innovative food production systems and strengthen its role as the leading international food standards organization.

Information on the relation between the proposal and other existing Codex documents as well as other ongoing work

16 The Code of Hygienic Practice will build upon and complement the General Principles of Food Hygiene (CXC 1-1969), addressing the specific hygiene requirements unique to cell-based food production. The proposed work will maintain consistency with existing Codex texts while providing additional guidance necessary for this specialized production system.

Identification of any need for technical inputs to the standard from external bodies

17 FAO/WHO has published comprehensive work on the food safety aspects of cell-based food, and there will be a need to seek further scientific advice from the experts involved in producing this document. Additional scientific input from FAO/WHO's expert body JEMRA may be required to establish appropriate microbial standards in the manufacture of cell-based foods. Technical expertise may also be drawn from the Good Food Institute, a non-profit organization and Codex Observer with extensive experience in alternative proteins including cell-based foods, precision fermentation, and biomass fermentation. Their insights, combined with input from regulatory bodies and scientific institutions experienced in cell-based food production, will be valuable in developing comprehensive hygiene guidelines for this emerging sector.

Proposed timeline for completion of the new work, including the start date, the proposed date for adoption at Step 5, and the proposed date for adoption by the Commission; the time frame for developing a standard should not normally exceed five years.

18 Subject to the agreement of the Committee and Codex Alimentarius Commission's approval, it is anticipated that the proposed work can be completed in three sessions of Codex Committee on Food Hygiene.

Annex 2

DRAFT CODE OF HYGIENIC PRACTICE FOR MANUFACTURING OF CELL-BASED FOODS

INTRODUCTION

This Code of Hygienic practice for manufacturing of cell-based foods is intended to provide guidance for safe production of cell-based foods.

This Code of Hygienic practice for manufacturing of cell-based foods takes into consideration, to the extent possible, the differing cell-based production and processing systems used by countries with manufacturing plants. It covers specific requirements for cell-based food production facilities and identifies essential principles of food hygiene applicable throughout the food chain to achieve safe cell-based food products. The Code will build up on the *General Principles of Food Hygiene (CXC 1-1969)*

1. OBJECTIVES

The Code of hygienic practice for manufacturing of cell-based food:

I. Provides specific principles and guidelines for the hygienic production of cell-based foods;

II. Identifies key hygiene controls at each production stage;

III. Provides guidance on specific applications where enhanced controls are needed.

2. SCOPE AND USE OF THE DOCUMENT

2.1 SCOPE

This document provides a framework of principles for producing cell-based food safe for human consumption by outlining necessary hygiene and food safety controls to be implemented in cell banking, production, processing, manufacturing, preparation, packaging, storage of cell-based food products, and where appropriate, specific food safety control measures at certain steps throughout the food chain.

2.2 USE OF THE DOCUMENT

The provisions of this document are supplemental to and should be used in conjunction with the *General Principles of Food Hygiene (CXC 1-1969).*

This document consists of a series of principles, explanatory narratives and guidelines.

Principles, shown in **bold text**, are statements of the goal or objective that are to be achieved, *Explanatory narratives,* shown in *italicized text*, serve to explain the purpose of the stated principles. Additional information to assist in the application of the stated principles is shown in normal text.

2.3 PRINCIPLES APPLYING TO THE PRODUCTION, HANDLING AND PROCESSING OF ALL CELL-BASED FOOD PRODUCTS

The following principles should apply, where appropriate and practicable, to the production, handling and processing of all cell-based food products.

- From cell-based food production to the point of consumption, cell-based food should be subject to control measures intended to achieve the appropriate level of public health protection.
- Where appropriate, hygienic practices for cell-based food should be implemented within the context of HACCP systems as described in the Annex to the General Principles of Food Hygiene (CXC 1-1969)
- Control measures should be effective and validated, where practicable.

2.4 RELATIVE ROLES OF CELL-BASED FOOD BUSINESS OPERATORS

- Good communication and interaction should exist in the chain so that an effective chain of controls is maintained from culturing to expansion and finally harvesting of cells for consumption. This can help to ensure that appropriate and complementary hygiene practices are applied at each stage of the chain and that appropriate and timely action is taken to resolve any food safety problems that may arise.

- Cell-based food business operators should apply good hygienic, consistent with food safety, and adapt their operations as appropriate and practicable to meet any specifications for specific hygiene controls to be applied and/or any standards to be achieved.
- Cell-based food business operators should follow good manufacturing and good hygienic practices, especially those presented in this Code and in the *General Principles of Food Hygiene (CXC 1-1969)* or those required by the competent authority. The processor may have to implement controls, or adapt their manufacturing processes, based on the ability of the producer to minimize or prevent associated hazards.
- Cell-based food business operators should communicate any recommendations for safe handling and storage of cell and cell-based food products during distribution and transportation, and their subsequent use by food businesses.
- Cell-based food business operators involved in food preparation at any facility should ensure that cell-based food products under their control are handled and stored properly and according to the producers and/or processors instructions.
- Information to consumers should include advice on safe handling, storage and preparation of cell-based food.

2.5 DEFINITIONS

Refer to definitions in the *General Principles of Food Hygiene (CXC 1-1969)* and other applicable Codes. In addition, for the purpose of this Code, the following expression have the meaning stated:

Aseptic – commercially sterile

Cell-based foods − Foods produced through the culturing of cells isolated from animals, including cells from poultry, bovine, porcine, fish and crustacean sources.

Cell-based food business operators **−** Entity responsible for operating a cell-based business at any step in the food chain

Clean room − Controlled environment meeting minimum requirements of ISO 8 or Class 100,000 standards.

Good Cell Culture Practice (GCCP) − Guidelines ensuring quality and standardization in cell culture procedures.

3. CELL-BASED FOOD PRODUCTION

Cell-based food business operators **should take all reasonable measures to reduce the likelihood of hazards occurring in or on cells during primary production.**

Cell-based food production activities such as cell banking, cell selections, and cell cultivation can significantly impact on the safety of the cells. Microbial contamination of cells can occur during cell expansion, thus the practices used at this phase of production are a key factor in reducing the potential for microorganisms to be present in or on cells.

The following guidelines are supplemental to those set forth in Section 8 of the General Principles of Food Hygiene (CXC 1- 1969) for establishments that produce cell-based food.

3.1 ENVIRONMENTAL HYGIENE

- Consideration of potential sources of contamination from the environment
- Areas for cell culture operations should prevent introduction of contaminants
- Clean room facilities, if provided, must meet the minimum requirement of ISO 8 or Class 100,000, or its equivalent
- Ventilation system must provide sufficient clean air and prevent airflow from contaminate to clean areas.
- Ventilation openings must be screened and equipped with proper air filters.

3.2 HYGIENIC PRODUCTION OF CELL CULTURE MATERIALS

- Master cell banks must be properly characterized and documented

- Cell culture media and components require certificates of analysis
- Implementation of Good Cell Culture Practice (GCCP)

3.3 DOCUMENTATION AND RECORD KEEPING

Records should be kept, as necessary and where practicable, to enhance the ability to verify the effectiveness of the control systems. Documentation of procedures can enhance the credibility and effectiveness of the food safety control system

With respect to food safety, records should be kept on:

- Identification and movement of cell lines used in the manufacturing establishment
- Use of antibiotics in the maintenance of cell lines
- Source and quality of all media inputs (growth factors, medium, water etc)
- Results of testing where testing is performed
- Health status of personnel
- Cleaning and disinfection
- Traceability/product tracing[12] and recall
- Preventive maintenance

4. ESTABLISHMENT: DESIGN AND FACILITIES

The following guidelines are supplemental to those set forth in Section 9 of the General Principles of Food Hygiene (CXC 1- 1969) for establishments that produce cell-based food.

4.1 Design and layout of establishment

The following should be considered, where practicable, separate area should be allocated for:

- Cell-based production and conventional food processing co-located in the same facility;
- Unidirectional product flow to prevent cross-contamination;
- Separate entry/exit points for raw materials and finished products;
- Hygienic design for bioreactor systems;
- Dedicated rooms or time-separated processes for:
    - Cell selection
    - Cell cultivation
    - Harvesting

4.1.1 Clean Room Requirements

- Refer to 3.1 of this Code
- Positive air pressure maintenance
- Proper air filtration systems
- Ventilation preventing airflow from contaminated to clean areas
- Regular monitoring of environmental conditions

5. CONTROLS OF OPERATION

[12] Refer to Principles for Traceability/Product Tracing as a Tool within a Food Inspection and Certification System (CXG 60-2006)

These guidelines are supplemental to those set forth in Section 13 of the *General Principles of Food Hygiene (CXC 1- 1969).*

This section refers to control measures that should be taken to prevent, eliminate, or reduce hazards when producing cell-based food. These measures should be used in conjunction with good hygiene and animal husbandry practices for the primary production of cell lines in order to provide an effective system of control of microbiological and other hazards that can occur.

5.1 CONTROL OF FOOD HAZARDS

Cell-based food should be safe and suitable.

- Implementation of HACCP-based systems
- Identification of critical control points specific to cell-based production
- Monitoring and validation of control measures
- Documentation of control measures

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.1 Temperature Control and time issue

From the receipt of cells, through handling, cultivation, propagation, washing, packing, storage and distribution to point of consumption, consideration should be given to time and temperature conditions for cell-based food such that the growth of pathogenic microorganisms will be minimized, and the safety and suitability of cells-based food will not be adversely affected.

Temperature fluctuations should be minimized as much as possible.

- Adequate cold storage facilities (-80°C to 4°C as required) based on intended products
- Temperature monitoring and recording systems
- Proper thawing procedures for biological materials

5.2.2 Specific Process Steps

- Aseptic techniques for cell culture operations
- Media preparation controls
- Cell harvesting protocols
- Product processing parameters

5.3 INCOMING MATERIAL REQUIREMENTS

- Supplier approval program
- Certificates of Analysis for all inputs
- Verification of specifications
- Storage according to material requirements

5.4 MANAGEMENT AND SUPERVISION

- Documented food safety management system
- Implementation of Good Cell Culture Practice
- Training programs for personnel

6. ESTABLISHMENT: MAINTENANCE AND SANITATION

These guidelines are supplemental to those set forth in Section 11 of the *General Principles of Food Hygiene (CXC 1-1969).*

6.1 WASTE MANAGEMENT

- Segregation of general and biohazardous waste

- Licensed waste collectors for disposal
- Decontamination procedures for biological waste
- Compliance with regulatory requirements

7. TRANSPORTATION

These principles and guidelines are supplemental to those set forth in Section 15 of the *General Principles of Food Hygiene* (CXC 1-1969) and, as appropriate, those set forth in *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food (CXC 47 – 2001).*

Raw cells and cell-based food production should be transported in a manner that will minimize damage and contamination.

Cells and cell-based products should be transported between establishments promptly. Cells and cell-based products should be maintained at an appropriate temperature, including avoiding fluctuations in temperature that will result in cell integrity loss.

8. PRODUCT INFORMATION AND CONSUMER AWARENESS

These principles and guidelines are supplemental to those set forth in Section 14 of the *General Principles of Food Hygiene* (CXC 1-1969).

8.1 LABELLING

- Compliance with relevant regulations
- Clear identification as cell-based product
- Storage and handling instructions

8.2 CONSUMER EDUCATION

When appropriate, advice should be made available to consumer on safe handling, use, preparation and consumption of cell-based food.

9. TRAINING

The following guidelines are supplemental to those set forth in Section 10 of the *General Principles of Food Hygiene (CXC 1- 1969)* for establishments that produce cell-based food.

9.1 AWARENESS AND RESPONSIBILITIES

- Compliance with relevant knowledge on food safety
- Understanding of cell-based production processes
- Knowledge of critical control points

9.2 TRAINING PROGRAMMES

- Basic food hygiene
- Clean room operations
- Good Cell Culture Practice
- Specific job responsibilities
- Documentation procedures

Appendix III

PROPOSAL FOR REVISION OF *CODE OF PRACTICE FOR THE PROCESSING AND HANDLING OF QUICK FROZEN FOODS* (CXC 8-1976)

(Prepared by Chile)

EXECUTIVE SUMMARY

Chile proposes revising the Code of Practice CXC 8-1976 to allow poultry and pork meat, offal, and by-products to be frozen, stored, transported, and sold at a temperature equal to or below −15 °C, instead of the current −18 °C standard, provided that effective cold chain control is ensured.

This proposal, submitted by the Government of Chile to the Codex Committee on Food Hygiene (CCFH), is based on recent scientific evidence demonstrating that −15 °C maintains the microbiological safety of meat and cause only minor effects on organoleptic quality during long-term storage.

The reviewed studies indicate that at temperatures below −12 °C, there is no proliferation or enzymatic activity of relevant pathogens. Furthermore, lipid oxidation, discoloration, and texture changes remain within acceptable ranges for at least 12 months of storage at −15 °C. In terms of sensory and nutritional quality, the effects are comparable to those at −18 °C and depend on the type of product, fat content, and packaging technology.

From a risk management standpoint, it is proposed to establish −15 °C as the limit, with a narrow critical tolerance up to −12 °C. This management should be complemented by continuous monitoring systems, alarms, and corrective actions in case of deviations. It is recommended to validate shelf-life by product type up to 24 months, ensuring that neither safety nor quality is compromised.

f-life by product type up to 24 months, ensuring that neither safety nor quality is compromised.

A general update to CXC 8-1976 is proposed to recognize −15 °C as the freezing temperature for poultry and pork meat products, adjusting the relevant references in the sections on definition, freezing process, storage, transport, sale, and temperature monitoring. The principle of “rapid freezing” and the requirements applicable to other foods remain unchanged.

The expected impact includes a significant reduction in energy consumption and greenhouse gas emissions: up to 17.7 million tons of CO_2e per year (equivalent to 4 million vehicles) and a global energy saving estimated at 25 TWh/year.

Chile’s proposal modernizes the Codex standard in line with the latest scientific evidence, strengthens risk-based management, and promotes a more efficient and sustainable cold chain.

Annex 1

PROJECT DOCUMENT

REVISION OF *CODE OF PRACTICE FOR THE PROCESSING AND HANDLING OF QUICK FROZEN FOODS* (CXC 8-1976)

1. OBJECTIVE AND SCOPE

Update the freezing temperature for poultry and pork meats from −18 °C to −15 °C, provided effective cold-chain control is maintained. This entails proposing a revision / amendment to the CXC 8-1976 Code of Practice of the Codex, limited to poultry and pork meats (carcasses, cuts, giblets, and edible by-products). It applies to freezing, cold storage, shipping, distribution centers, land and sea transport, and wholesale/retail sale.

2. BACKGROUND AND TECHNICAL JUSTIFICATION

The −18 °C (0° F) benchmark was historically adopted as a global standard without corresponding to a specific microbiological threshold for meats. Contemporary evidence indicates that, with management of possible temperature fluctuations and good packaging, −15 °C preserves microbiological safety and causes limited quality impacts during storage, while reducing energy consumption and greenhouse gas emissions in the cold chain.

There are also regulatory precedents allowing scientifically justified alternative conditions or operational tolerances, and commercial practices already operating at −15 °C in certain stages of poultry and pork frozen meat production and logistics.

3. RISK PROFILE – SUMMARY

1) Relevant hazards:

- Microbiological hazards like *Salmonella* spp., *Campylobacter* spp., and spoilage flora. At freezing temperatures below −12 °C, pathogens like *Salmonella* spp. and *L. monocytogenes* are not viable; psychrophilic bacteria and molds have minimal growth between −2 °C and −8 °C, respectively. Therefore, no microbiological safety risk from pathogen proliferation exists if the freezing temperature is maintained below −15 °C, even if temperatures reach up to −12 °C.
- Organoleptic and nutritional quality loss. Although not a safety hazard, analyzing this is relevant to ensure product quality. In studies (up to 6 months of storage) at −15 °C, meats show no significant differences in pH, lipid oxidation, water retention, or volatile nitrogen compared to −18 °C. However, at −15 °C, over storage periods longer than 12 months, lipid oxidation (rancidity) and pigment oxidation (discoloration) may accelerate, potentially causing perceivable changes in odor/taste, color, texture, and possible nutritional value loss. Quality modeling estimates that a 3 °C increase in freezing temperature could reduce sensory shelf life by about 30% (without compromising safety), so practical shelf life at −15 °C could be shorter than at −18 °C and will depend on matrix (poultry vs. pork), fat content, and packaging technology.

2) Hazard exposure characterization:

At ≤ −15 °C there is no bacterial growth, but some bacteria may survive long-term freezing; thus, risk focuses on potential temperature fluctuations approaching thawing temperature.

Quality/nutritional deterioration from rancidity, discoloration, protein degradation, and texture/moisture changes may occur during extended storage at −15 °C, especially beyond 12 months. This deterioration is governed by lipid oxidation, protein and pigment degradation, and physical damage from ice and water.

3) Proposed risk management:

Maintain −15 °C as a critical limit, with strict operational tolerances, continuous temperature monitoring, alarms, records, and corrective procedures.

Confirm organoleptic/nutritional quality by product type for up to 24 months, especially for sensitive products (e.g., high-fat products, giblets, and by-products).

4) Data gaps:

Comparative series specific to −15 °C vs. −18 °C for poultry and pork that assess sensory/nutritional quality beyond 12 months up to 24 months are lacking. Because this is an area of quality, three alternatives are proposed:

I. Carry out a Chilean-designed shelf-life study with Chilean poultry and pork products (from 0 to 24 months) to evaluate microbiological, physicochemical, sensory and nutritional parameters at −15°C vs −18°C;

II. If the CCFH considers it appropriate, it may request the opinion of the Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA). If data on a 24-month product shelf life are

required, Chile could undertake this study in accordance with the guidance of the JMPR;

III. Not conducting a shelf-life study, as this is not a safety risk, but is a quality issue that every company, producer, and exporter must consider.

4. PROPOSED MANAGEMENT MEASURES

Set a critical limit of ≤ −15 °C for poultry and pork, with an operational limit not exceeding ≤ −12 °C. Any temperature rise above −15 °C must be brief, not compromise safety or quality, and the cause must be recorded. A system with continuous temperature monitoring, alarms, and corrective actions must be in place to minimize time in warmer ranges. Prioritize packaging with O_2 barrier and vacuum adjustment to reduce oxidation.

5. MAIN ASPECTS TO BE COVERED

We propose to revise / amend the CXC 8-1976 Codex Code of Practice to raise the critical freezing, storage, shipping, transport, and retail temperature for poultry and pork meats to ≤ −15 °C.

To this end, we submit the following specific editorial proposals for inclusion in the relevant sections of the Code:

1) Section 2. DEFINITIONS

In the definition of “Quick frozen food”, the following revised text (in bold and underlined) is proposed:

Food which has been subjected to a quick freezing process, and maintained at -18°C or colder at all points in the cold chain, subject to permitted temperature tolerances, ***except for pork and chicken meat where the temperature will be -15°C****.*

2) Section 3.1.3 Cold Store Design

In the first bullet point, we propose the following revision:

Adequate refrigeration capacity provides and maintains a product temperature of -18°C or colder ***or -15°C according to the definition of Quick frozen food***;

3) Section 4.3 QUICK FREEZING PROCESS

We propose adding a fourth paragraph with the following wording:

In the case of pork and chicken meat, the quick freezing process should not be regarded as complete until and unless the product temperature has reached -15°C or colder at the thermal centre, after the stabilization of the temperature. On exit from the freezing apparatus, the product should be moved to a cold store as quickly as possible in order to minimise exposure to warm temperatures and high humidity and to maintain the product temperature at -15°C or colder. The same applies to products that are retail packed after the quick freezing process (see Section 4.8)*.*

4) Section 4.7 TRANSPORT AND DISTRIBUTION

In the first paragraph, we suggest the following amendment:

…The transport of quick frozen foods (e.g. from cold storage warehouse to cold storage warehouse) should be carried out in suitably insulated equipment that ideally maintains a product temperature of -18°C or colder, ***or -15°C or colder for pork and chicken meat****. The product temperature should be at -18°C or colder,* ***or -15°C for pork and chicken meat*** *at the beginning of the transport.*

In the fourth paragraph of the same section, we suggest the following revision:

Distribution of quick frozen foods should be carried out in such a way that any rise in product temperature warmer than -18ºC ***or-15°C, as the case may be for pork and chicken meat,*** *be kept to a minimum within, as appropriate, the limit set by competent authorities and should not in any case be warmer than -12ºC in the warmest package to ensure quality of the products. After delivery, the product temperature should be reduced to -18°C* ***or -15°C*** *as soon as possible.*

5) Section 4.9 RETAIL SALE:

In the first paragraph, we propose the following amendment:

Quick frozen foods should be offered for sale from freezer cabinets designed for the purpose. Cabinets should be capable of maintaining and be so operated as to maintain a product temperature of -18°C ***or -15°C for pork and chicken meat****. A rise in product temperature may be tolerated for short periods, with any rise warmer than -18ºC* ***or -15°C*** *kept to a minimum, within, as appropriate, the limit set by competent*

authorities, and should not in any case be warmer than -12ºC in the warmest package.

In the last paragraph of this section, we propose the following revision:

*The retail establishment should have an appropriate back-up storage for quick frozen foods that allows products to be kept at a temperature of -18ºC **or -15°C for pork and chicken meat**.*

6) Section 5.1 TEMPERATURE MONITORING

In the first paragraph, we suggest the following revised text:

*Operators should ensure that appropriate systems are in place to monitor air temperatures during the freezing process and to monitor temperature along the cold chain in order to ensure that the product temperature is maintained at -18ºC, **or -15°C for pork and chicken meat**, or colder within the permitted tolerances set by competent authorities.*

6. AN ASSESSMENT AGAINST THE CRITERIA FOR ESTABLISHMENT OF WORK PRIORITIES

General criterion

- Consumer protection from the point of view of health, food safety, ensuring fair practices in the food trade and taking into account the identified needs of developing countries

The proposed revision will support competent authorities and food business operators in implementing control measures.

Criteria applicable to general subjects

Frozen poultry meats and pork represent a high volume of global trade, with constant use of storage and refrigerated containers. FAO estimates trade volume for poultry reached 16.3 million tonnes in 2024 and pork trade volume projected at 10.0 million tonnes in 2024 (Meat Market Review 2024).

Expected impact: reduced energy costs, lower GHG emissions, improved logistics efficiency without compromising safety, with limited quality loss during extended storage (>12 months). Estimated annual reduction of up to 17.7 million tonnes CO_2e—equivalent to emissions from 4 million vehicles—and global energy savings equivalent to 25 TWh/year (Three Degrees, 2023). Also, reduced waste from handling due to higher freezing points along the logistics chain.

- **Is there new information justifying revision?** Yes. Recent technical literature and reviews from 2023–2025; also plan for comparative 24-month shelf-life study.
- **Public health impact:** MEDIUM (14), due to maintained safety and improved system robustness (less food waste) and indirect nutritional benefits from stable protein availability from frozen poultry and pork.
- **Trade impact regarding public health risk**: Global, high consumption (10), covering frozen chicken and pork in international trade. FAO estimates trade volumes as noted earlier.

7. RELEVANCE TO THE CODEX STRATEGIC OBJECTIVES

The proposed work aligns significantly with several Codex strategic goals from the Codex Strategic Plan 2026-2031:

- Strategic Goal 1: Response to Members' needs for protecting the health of consumers and ensuring fair practices in the food trade in an evolving global landscape by developing science-based standards and related texts.

8. INFORMATION ON THE RELATION BETWEEN THE PROPOSAL AND OTHER EXISTING CODEX DOCUMENTS AS WELL AS OTHER ONGOING WORK

- **CXC 8-1976** (subject to revision): review / amendment limited to freezing temperature for poultry and pork; does not alter "Rapid Freezing" definition or process.
- **CXC 1-1969** (General Principles of Food Hygiene) and **CXC 58/2005** (Hygiene Code for Meat): proposals reinforce risk-based approach and operational control.

9. IDENTIFICATION OF ANY REQUIREMENT FOR AND AVAILABILITY OF EXPERT SCIENTIFIC ADVICE

It is proposed that the CCFH provide guidance on whether or not shelf-life estimations are necessary for poultry and pork stored at −15°C versus −18°C (from 0 to 24 months). Refer to risk profile point 3 – data gaps.

10. PROPOSED TIMELINE

- 2025 (CCFH 56): Approval of new work and approval of 24-month microbiological and shelf-life

study protocol.

- 2026 (CCFH 57): Presentation of interim results; drafting amendment text.
- 2027 (CCFH 58 / CAC): Adoption at Step 5/8 if appropriate.

11. REGULATORY AND MARKET REFERENCES (SUMMARY)

There are tolerances and alternative freezing temperatures allowed in some markets, permitting −15 °C under certain conditions such as in Chile, EU, Japan, and China.

Table 1. Regulatory and Comparative Practices:

Market / Rule	Reference	Tolerances	Standards / Regulations
European Union	−18 °C	+3 °C in transport; +6 °C in retail, under certain conditions	Reg. 853/2004
Japan	−18 °C	+3 °C in transport	Chile–Japan Agreement
China (bilateral MOU)	−15 °C	Shipping	Chile–China Agreement
Chile (RSA, transport)	≤ −18 °C	Temporary until −15 °C (prompt correction); local delivery not exceeding −12 °C	Decree 977/96, Food Sanitary Regulation
Codex (CXC 8-1976)	−18 °C	+3 °C under certain conditions	CXC 8-1976

12. PROPOSED REVISION / AMENDMENT TEXT (DRAFT)

CXC 8-1976, in point 1 of "Scope and Objective," proposes removing the reference to poultry meat and adding a new paragraph below that reads, "When effective cold chain control and food safety management systems are in place, frozen poultry and pork may be frozen, stored, dispatched, transported, and consumed at temperatures ≤ −15°C, with short-term temperature fluctuations not exceeding −12°C under any circumstances. In addition, temperature records, alarms, corrective actions, and shelf-life validation will be required depending on the product type. This provision does not change the requirements for quick freezing." (*The final text will be adjusted to the Codex editorial format during the stepwise process*.

CXC 8-1976, in all places where a temperature of −18°C is referred to, specifically:

I. In the definition of quick-frozen food
II. In point 3.1.3 on cold storage design in its first bullet
III. In point 4.3 on quick freezing process in its third paragraph
IV. In point 4.6 on freezer storage in its first paragraph
V. In point 4.7 on transport and distribution in its first and fourth paragraphs
VI. In point 4.9 on retail sales in its first and last paragraphs
VII. In point 5.1 on temperature monitoring in its first paragraph

It is proposed to add a footnote stating that for poultry meat, pork, offal, and poultry and pork by-products, the temperature limit should be set to -15°C.

13. BIBLIOGRAPHY

- Technical Report – Freezing Temperature Increase – ChileCarne (V.2).
- Technological Aspects of Food Freezing (technical compendium).
- Cook, A.H.; White, A. (1941). *Storage of pork at different freezing temperatures.*
- Food Research 6(3): 179–185.
- *Changes in the shelf life of frozen pork patties containing 10 and 15% fat.*
- *Microbiological Changes during Long-Storage of Beef Meat* (review).

- *Meat Market Review (2024).*
- *The Food Cold-Chain and Climate Change* (review).
- *Three Degrees of Change – Summary Report & Initial Findings* (2023).
- Le Bail, A. et al. (2025). *An overview of selected "subzero" temperature storage regimes of foods….*

Annex 2

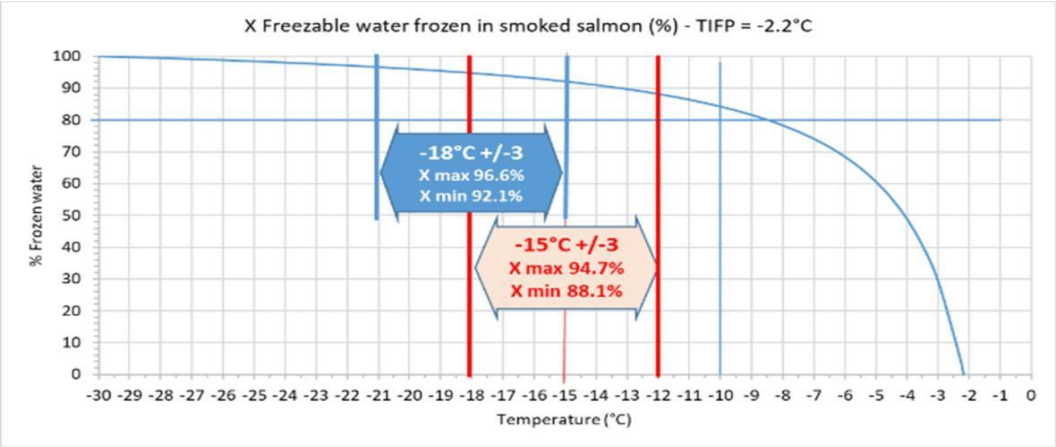
BIBLIOGRAPHIC REVIEW OF THE IMPACT AND CONSEQUENCES OF STORING PORK AND CHICKEN MEAT AT -15 ºC

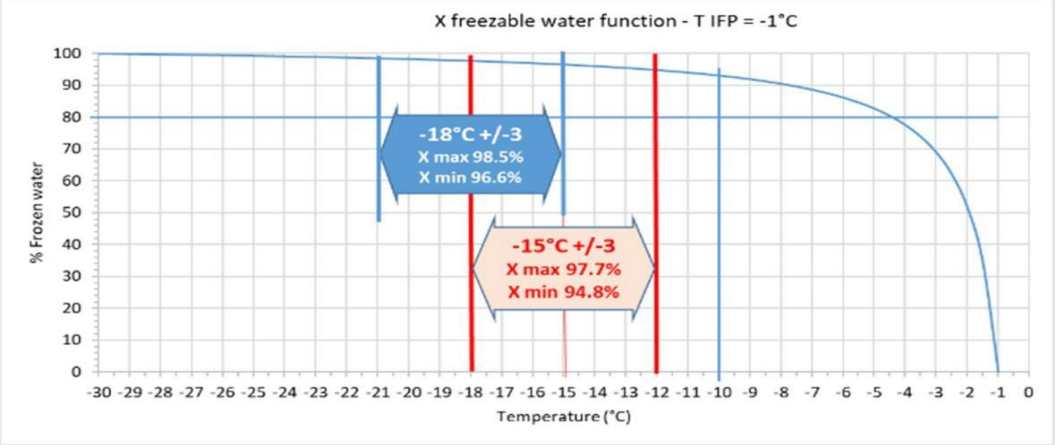
1. INTRODUCTION

At present, it is internationally accepted that -18 ºC is the temperature at which frozen foods should be stored and transported. There is evidence that at this temperature there is no microbial growth and that the quality of pork and chicken meat remains reasonably stable over a certain number of months. However, there are no studies justifying that -18 ºC is the maximum temperature ensuring these benefits, while there are studies showing that similar results can be achieved at -15 ºC. It is worth recalling that -18 ºC coincides suspiciously with 0 ºF (-17.8 ºC), and it is not unlikely that this value was originally chosen as a "round number" representing the temperature that guarantees the benefits of freezing. It should also be noted that when this value was established, there was no awareness or knowledge of climate change and the impact caused by excess CO_2 in the atmosphere. Today, the paradigm is different: the enormously negative impact of increased atmospheric CO_2 is well known, as is the potential reduction in CO_2 emissions that would result from raising the freezing temperature of foods by 3 ºC.

There is no evidence that the temperature of -18 ºC for the storage and transport of frozen foods was established based on rigorous data indicating that temperatures above this point compromise food safety or quality. The available data suggest that the temperature was set arbitrarily as a "round number" within the range in which food remains safe and maintains an extended shelf life for commercialization. The first research and publications on frozen foods were carried out in the United States, and it was likely for this reason that the "round" temperature of 0 ºF (-18 ºC) was adopted. Evidence of the arbitrariness of this chosen temperature lies in the fact that, at -18 ºC, the proportion of frozen water in most foods is not 100%—to reach this level, temperatures of around -30 ºC are required. Below, as an example, we reproduce the curves showing the percentage of frozen water as a function of temperature for two foods: one with a freezing onset temperature of -2.2 ºC and another with a freezing onset temperature of -1 ºC. These curves were developed by Le Bail et al., 2022, and show that above -10 ºC, more than 80% of the free water in the food is already frozen.

Figure 1. Percentage of frozen water in two foods: one with a freezing onset temperature of –2.2 ºC, and the other with a freezing onset temperature of –1 ºC. *Le Bail et al.* (2022)





The present study aims to review and analyze the information available in the scientific literature regarding the storage temperature of frozen foods, and to provide useful insights for discussion and decision-making concerning the proposed increase of three degrees in the storage and transport temperature of frozen pork and chicken meat.

2. IMPACT ON MICROBIAL FLORA

The scientific literature widely agrees that below -5 ºC there is no microbial growth in pork or chicken meat, nor in other foods, and that below -12 ºC no metabolic activity has been reported for any microbial population.

The study by Serena L., Vollebregt M., Meinders M., et al. (1) confirms that no microbial growth was observed in any of the foods studied (chicken, fish, vegetables, processed meat, and pizza) at any of the temperatures tested (-18 ºC, -15 ºC, -12 ºC, and -9 ºC) over a period of 18 months.

Le-Bail et al. (2025) (3) report a consensus that below -10 ºC no microbial growth occurs, and note that freezing reduces the water activity of food.

The British Frozen Food Federation (11), in the introduction to its Guide to the Storage & Handling of Frozen Foods (2017), states that there is no risk of microbial growth in any frozen food unless its temperature is maintained above -12 ºC for a considerable period of time.

A.K. Pradhan et al. (2012) (14) conducted a study showing no growth and similar survival behavior of Listeria innocua and Salmonella Typhimurium populations in chicken breast fillets stored at -12 ºC and -20 ºC.

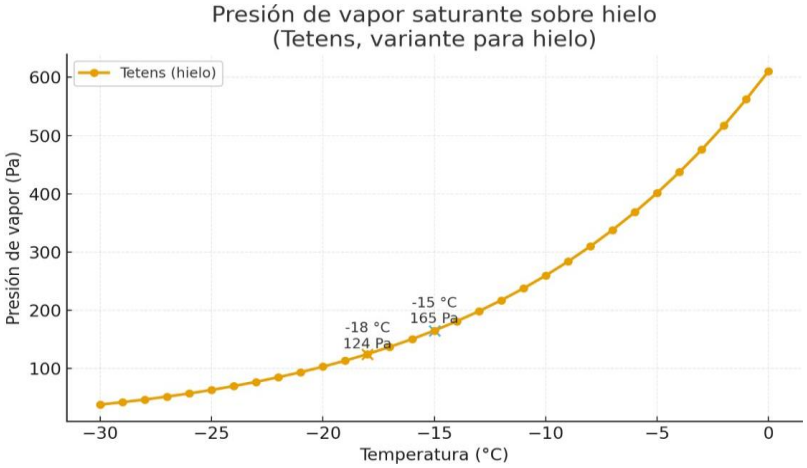
F. Fangfang et al. (2021) (15), in their study on beef rolls, reported no differences in total volatile basic nitrogen (TVB-N) content after 180 days of storage at -12 ºC and -18 ºC.

These findings support the conclusion that at -15 ºC, no microbial growth or metabolic activity is expected in pork or chicken meat, or in other foods.

3. IMPACT ON SENSORY CHARACTERISTICS

The sublimation of ice (the direct transition of water from solid to gaseous state) is more intense at -15 ºC than at -18 ºC. This is due to variations in vapor pressure, which decreases as temperature decreases. Below is a graph illustrating the variation in vapor pressure as a function of temperature, calculated using the Tetens formula.

Figure 2. Subzero Ice Vapor Pressure Profile (Tetens Model) and the Vapor Pressure Gradient Between −18 °C and −15 °C



As can be seen, the vapor pressure of ice at -15 ºC (165 Pa) is 33% higher than at -18 ºC (124 Pa). As a result of this higher vapor pressure, foods stored at -15 ºC dry out more quickly than those stored at -18 ºC, leaving their fat more exposed to the oxygen in the package headspace and accelerating the oxidation process. All of this leads to a faster degradation of sensory characteristics, the magnitude of which depends, among other factors, on the structure and composition of the food and on the composition of the atmosphere in contact with its surface.

Serena L., Vollebregt M., Meinders M., et al. (1) report a gradual increase in the degradation of sensory characteristics as the storage temperature rises during freezing. In the cited study, the two meat products analyzed (crispy chicken and meatballs) were rated as excellent after 18 months, whether stored at -18 ºC or -15 ºC. For other types of foods (not meat), the study indicates a slight acceleration of sensory degradation when the storage temperature increases.

Le-Bail et al. (2025) (3) report a 30% reduction in the shelf life of packaged chicken meat (4), as measured by an expert panel, and a 26% reduction in chicken meat shelf life (5), as measured by a non-trained consumer panel, when products are stored at -15 ºC instead of -18 ºC. In the case of lean pork meat (without fat covering), measuring fat oxidation, the same authors report a 24% decrease in shelf life when the meat is stored at -15 ºC instead of -18 ºC (6).

The World Food Logistics Organization of the Global Alliance for Improved Nutrition, in 2008 (10), published the document *Frozen Foods Handling & Storage*, which states that the quality of lean meat stored for 16–70 months at -20 ºC is equivalent to that achieved after 10–37 months at -15 ºC, and that the quality of fatty meat stored for 13–40 months at -20 ºC is equivalent to that achieved after 10–27 months at -15 ºC**.** Below reproduces the data from this study.

Table 1. Shelf life (Practical Storage Life, PSL) of selected foods as a function of storage temperature. *(World Food Logistics Organization, WFLO, 2008)*

Storage Temp.		Practical Storage Life, in Months						
° F	° C	Raw and pre-cooked lean meat	Raw and pre-cooked fat meat	Lean fish	Pre-cooked foods without gravy	Fat fish without any special treatment	Fruits and berries	Vegetables
23	- 5	2-12	1 - 5	1- 3	2- 6	1- 2	1- 5*	1- 4
14	-10	5-21	6-17	2- 6	3- 9	1- 3	3- 17	3- 10
5	-15	10-37	10-27	4-12	5-15	2- 5	17-70	8-20
-4	-20	16-70	13-40	6-20	8-28	3- 8	Over 70	21-70
-13	-25	30-70 +	20-60	11-40	15-47	4-12	--	---
-22	-30	53-70 +	30-70 +	---	27-70 +	6-18	---	---

F. Fangfang et al. (2021) (15), in their study on beef rolls, reported that color was better preserved when stored at -18 ºC rather than -12 ºC over a 180-day period, except in packages containing 20% CO_2.

These data suggest that at -15 ºC, a greater rate of sensory degradation may occur in meat products, though

not necessarily a greater *extent* of degradation. This change may result, in some foods, in a reduction of up to 30% in shelf life.

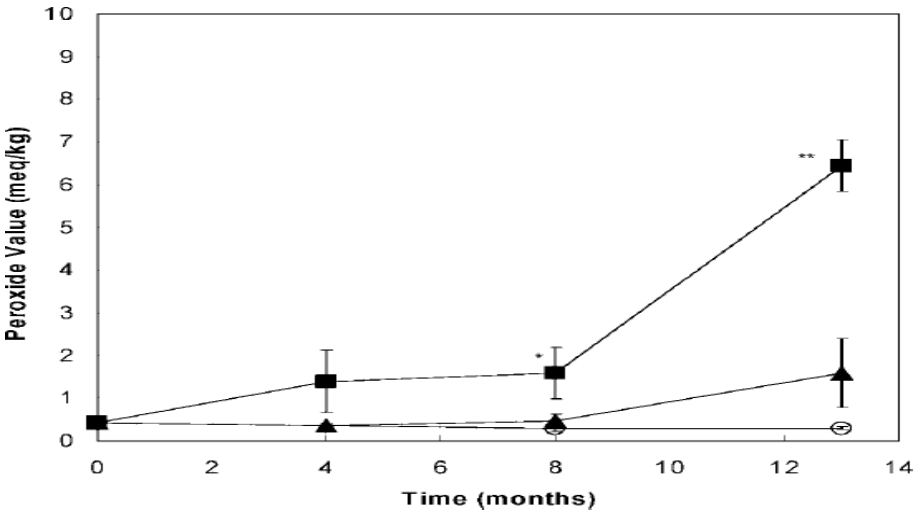
4. RANCIDITY AND FAT OXIDATION

As previously described, when the storage temperature increases from -18 ºC to -15 ºC, there is a higher proportion of free (unfrozen) water and less protection from the ice layer covering the fat, due to its greater tendency to sublimate. These two factors lead to greater molecular mobility, higher activity of oxidative enzymes, and increased access of oxygen from the headspace to the fats in the food. All of this results in an acceleration of fat oxidation processes.

F. Fangfang et al. (2021) (15), in their study on beef rolls, reported that those stored at -12 ºC underwent greater oxidation than those stored at -18 ºC. Specifically, after 180 days at -12 ºC, beef rolls packaged with 80% O_2 + 20% CO_2 showed an average content of 1.21 mg malondialdehyde/kg, compared to an average of 0.40 mg malondialdehyde/kg in the same product packaged under identical conditions. The indicated difference was smaller or nonexistent under other packaging conditions.

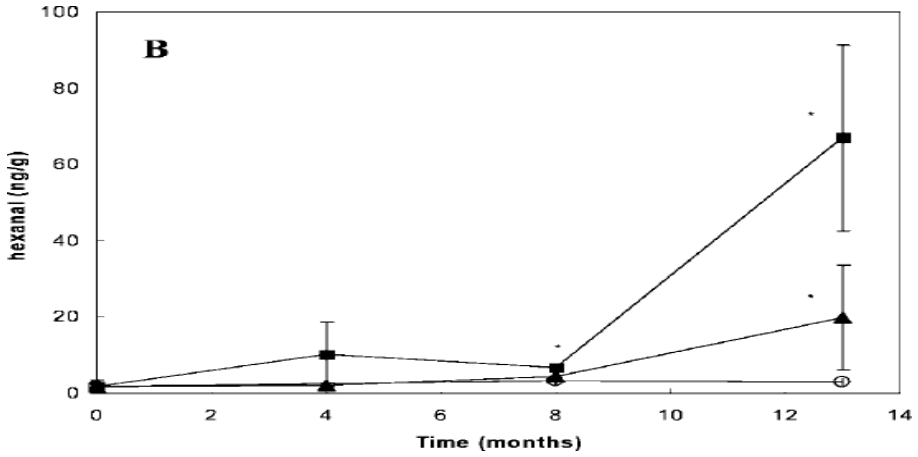
C.P. Baron et al. (2007) (16) reported a greater increase in hydroperoxides in trout stored at -20 ºC, compared with those kept at -30 ºC and -80 ºC. Specifically, they observed 7 meq/kg of peroxides after 13 months of storage at -20 ºC. Trout meat stored at -80 ºC maintained a content of <1 meq/kg, while that stored at -30 ºC showed a value of approximately 1.5 meq/kg over the same 13-month period.

Figure 3. Evolution of peroxide content in trout meat stored at -20 ºC, -30 ºC, and -80 ºC. *(C.P. Baron et al., 2007)*



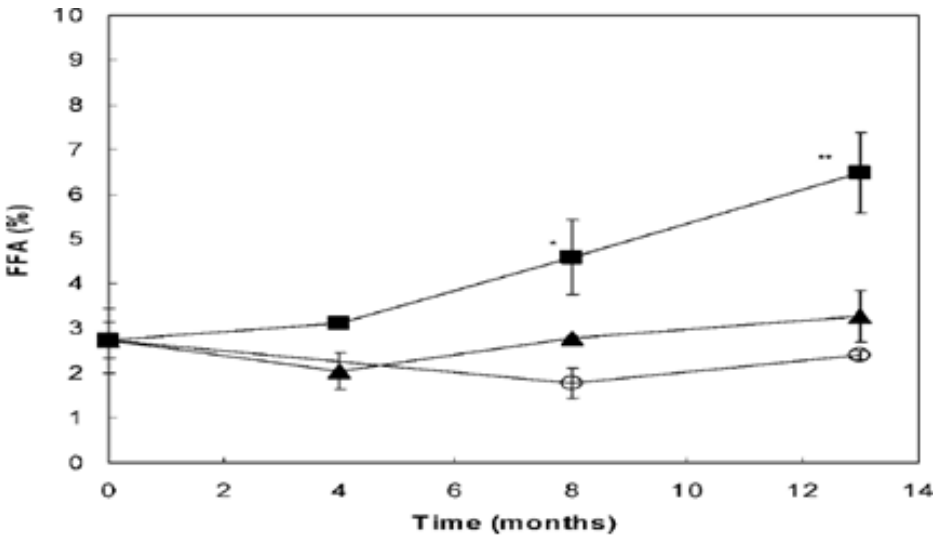
The same trend is observed in hexanal content, which increases from levels close to 0 ng/g in trout stored at -80 ºC, to 20 ng/g in trout stored at -30 ºC, and to 70 ng/g in trout stored at -20 ºC, over a 13-month period. Figure 4 illustrates these data.

Figure 4. Evolution of hexanal content in trout meat stored at **-20 ºC**, **-30 ºC**, and **-80 ºC**. *(C.P. Baron et al., 2007)*



The same trend is also observed in free fatty acid content, which increases from 2% in trout meat stored at -80 ºC, to 3% in that stored at -30 ºC, and to 6% in that stored at -20 ºC, over a 13-month period. Figure 5 illustrates these data.

Figure 5. Evolution of free fatty acid content (expressed as % of oleic acid) in trout meat stored at - 20 ºC, -30 ºC, and -80 ºC. (C.P. Baron et al., 2007)



M. C. Tomás (1988), in his doctoral thesis (18), reported the importance of freezing storage temperature on the rate of fat oxidation processes, noting that the rate increases as temperature increases. The author also indicated that the oxidation rate is strongly influenced by the characteristics of the food, the composition of the air in the headspace, and the packaging material used.

5. LOSS OF NUTRIENTS AND ANTIOXIDANTS

Le-Bail et al. (2025) (3) reported that the 50% loss of vitamin C in peas and spinach occurs in half the time at -15 ºC compared to -18 ºC. Below are two graphs from studies conducted by Giannakourou and Taoukis (2003) (7) and Allouche et al. (2023) (8) that illustrate this finding.

Figure 6. Commercial shelf life of peas and spinach, based on 50% loss of vitamin C, as a function of storage temperature. *(Giannakourou and Taoukis, 2003)*

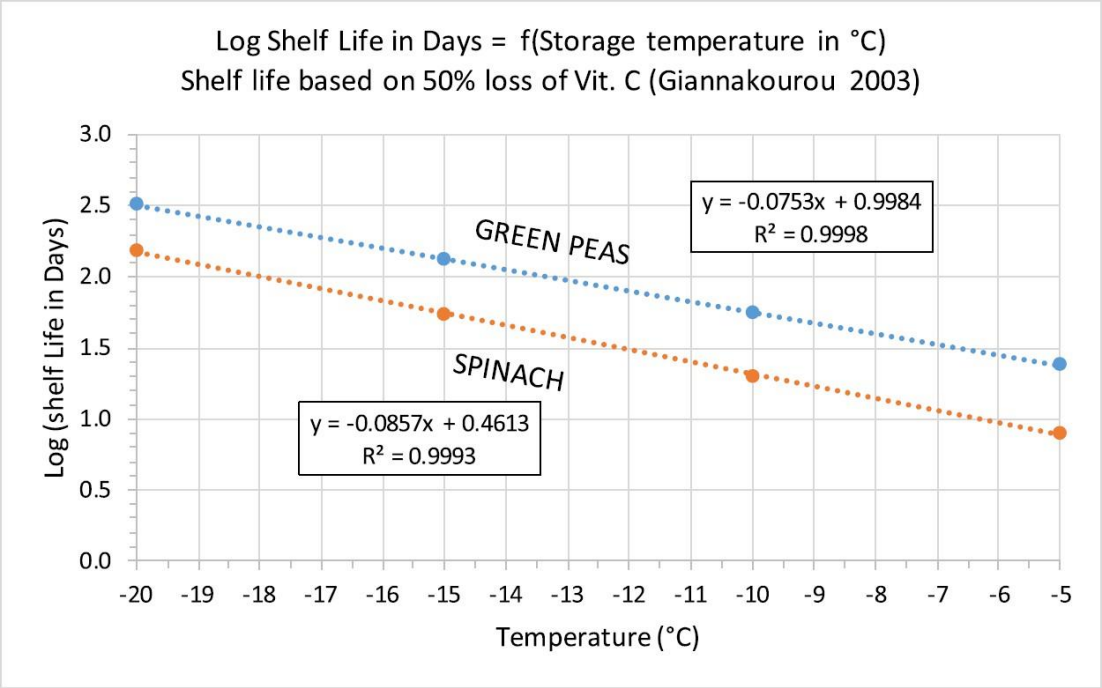
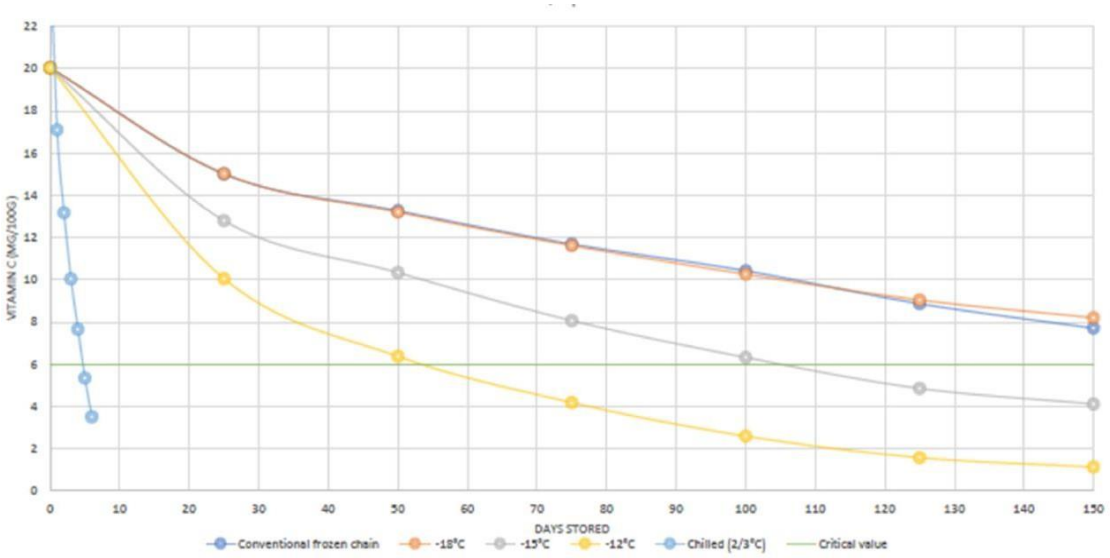


Figure 7. Decrease in vitamin C content in spinach at different storage temperatures: -18 ºC, -15 ºC, -12 ºC, and 2/3 ºC. *(Allouche et al., 2023)*



C.P. Baron et al. (2007) (16) reported a 15% loss of α-tocopherol in trout meat stored for 13 months at -20 ºC, compared to the same trout stored at -30 ºC or -80 ºC. Table 1 illustrates these data.

Table 2. Contents of α-tocopherol and astaxanthin in trout meat stored at -20 ºC, -30 ºC, and -80 ºC. (C.P. Baron et al., 2007)

storage temp (°C)	time (months)	tocopherol (mg/kg)	astaxanthin (mg/kg)
0	0	20.9 (±2.2)	9.8 (±3.0)
−20	13	14.5* (±1.0)	7.7 (±2.7)
−30	13	17.5 (±4.7)	8.2 (±3.2)
−80	13	16.2 (±6.5)	7.7 (±3.0)

*$p < 0.05$ against fresh frozen sample ($t = 0$).

6. DRIP LOSS

L.M. Diamante et al. (2016) (12) reported no observable differences in drip loss or in the protein content of the drip in beef flank frozen at -15 ºC, -36 ºC, or -78 ºC.

7. ENERGY SAVINGS AND IMPACT ON CO_2 EMISSIONS

The study by Allouche et al. (2023) (8) reported that raising the temperature of frozen foods from - 18 ºC to -15 ºC would result in an energy reduction of 5–7%, potentially reaching 10–12% in certain stages of the cold chain. This would translate into annual savings of about 25 TWh and a reduction of CO_2 emissions by approximately 17.7 million tons per year, equivalent to the emissions of 4 million gasoline-powered cars.

Nomad Foods, in its report Landmark study from Nomad Foods confirms potential to increase freezer temperatures and reduce carbon emissions (9), published in 2024, stated that storing foods at -15 ºC instead of -18 ºC reduces energy consumption by 10–11%, without any significant impact on food safety, flavor, or nutritional value. The study was commissioned to Campden BRI and carried out over six months.

On December 4, 2023, Multimodal published an article (13) stating that experts from the International Institute of Refrigeration (IIR, Paris), the University of Birmingham, and London South Bank University concluded that storing food at -15 ºC instead of -18 ºC would:

- Save 17.7 million metric tons of CO_2 emissions annually;
- Generate 25 terawatt-hours (TWh) of energy savings, equivalent to 8.63% of the UK's annual energy consumption; and
- Reduce frozen food supply chain costs by 5–12%, depending on the sector.

The research was conducted in collaboration with DP World, the main partner of COP28 (the 28th Conference of the Parties to the UN Framework Convention on Climate Change, held in Dubai, November–December 2023).

The International Institute of Refrigeration (IIR), on May 22, 2025 (17), published its Position Paper regarding the 3-degree increase (from -18 ºC to -15 ºC) in frozen food storage temperature. The document begins by noting that the definition of "frozen product" remains imprecise, and that the main consensus lies in reaching a temperature of -18 ºC, even though at that temperature most foods do not have 100% of their water frozen, but approximately 95%. According to the Institute's own 2006 recommendations, a food is considered "frozen" when its temperature is below -10 ºC or when more than 80% of its free water has frozen. Based on available scientific evidence and expert opinion, the document concludes that:

- Raising the storage temperature from -18 ºC to -15 ºC is expected to reduce energy consumption by about 10%.
- According to 18 studies reviewed by the Institute's experts, increasing the storage temperature from -18 ºC to -15 ºC is expected to reduce shelf life by approximately 30%, due to the accelerated aging of sensory attributes.
- Such a temperature change should be accompanied by stricter control of temperature fluctuations during storage.
- The temperature change may increase food waste if the shorter shelf life is not properly managed by operators.

The IIR document also proposes the following measures:

- For low-sensitivity foods, consider raising the storage temperature by 3 degrees (from -18 ºC to -15 ºC), with a maximum fluctuation of +3 ºC.
- For medium-sensitivity foods, the same 3-degree increase could be applied, but with a maximum fluctuation of +1 ºC.
- For high-sensitivity foods, the current storage temperature of -18 ºC should be maintained.

- The sensitivity level of a food should be determined based on its Q_3 value when stored at - 18 ºC (Q_3 being the ratio of the commercial shelf life at -18 ºC to that at -15 ºC).

It should be recalled that shelf life is determined by the manufacturer based on the product's characteristics, packaging, and marketing conditions. A slight reduction in shelf life for products stored at -15 ºC does not necessarily imply higher production costs (the production cost of a product with a 15-month shelf life need not exceed that of the same product with an 18-month shelf life) and does not increase CO_2 impact. Likewise, marketing costs would be lower for a 15-month product, both in energy use and storage time, resulting in a neutral or even reduced CO_2 footprint.

8. FINAL COMMENT

In summary, based on the analysis of available documentation and data—and with due respect to more authoritative opinions on the subject—the following conclusions can be drawn:

- Scientific evidence consistently indicates that below -12 ºC, no microbial growth or detectable metabolic activity occurs in foods, particularly in pork and chicken meat.
- Most sources indicate that at -15 ºC, a reduction in shelf life may occur due to a faster rate of sensory degradation, mainly from lipid oxidation, dehydration, and related reactions. The extent of this reduction depends on factors such as food type, package atmosphere, packaging material, and storage conditions. Under unfavorable conditions, the reduction in shelf life may reach up to 30%, while under optimal conditions it may be minimal or negligible.
- Shelf life is determined by the producer or distributor, and whether it is longer or shorter has no direct impact on the consumer (product quality must be maintained throughout its declared shelf life) or on society (no higher production or energy costs are expected from shortening a frozen product's shelf life by 30%).
- According to the reviewed literature, increasing the storage temperature by three degrees (e.g., from -18 ºC to -15 ºC) could result in an approximate 10% reduction in energy consumption.